Application No. 10/720,122
Declaration under 37 C.F.R. 1.132
Docket No.: 245926US0X DIV

IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

IN RE APPLICATION OF: GROUP: 1792
Toshio TSUJIMOTO, et al.

SERIAL NO: 10/720,122 EXAMINER: Song, Matthew J.

FILED: November 25, 2003

FOR: SURFACE MODIFICATION PROCESS OF QUARTZ GLASS CRUCIBLE

DECLARATION UNDER 37 C.F.R. § 1.132

COMMISSIONER FOR PATENTS
ALEXANDRIA, VIRGINIA 22313

Sir:

Now comes Yoshiyuki Tsuji who deposes and states that:

1. I am a graduate of Kyoto University and received my bachelor's degree in the year 1968.

2. I have been employed by Mitsubishi Materials Quartz for 16 years as a engineer in the field of quartz crucible.

3. The following calculations were carried out by me or under my direct supervision and control.

The thickness of the mixed metal oxide layer after baking of examples A-F as shown in Table 2 on page 18 in the specification was calculated as shown on the attached "Calculation method of thickness of mixed oxide layer." In this calculation, densities of the mixed oxide of SiO_2 and BaO are calculated based on a specific gravity of SiO_2 glass of 2.20 g/cm^2 and 5.72 g/cm^2 for BaO. As shown in the attached calculations, in Example A, the weight ratio of BaO/SiO_2 is 1/2 and therefore the volume of the metal oxide and the SiO_2 can be determined as 0.175 cm^3 and 0.909 cm^3 respectively. The total volume of Mixed oxide is therefore 1.084 cm^3 and the density is calculated to be 2.77 g/ cm^3.

From Table 2, the measured adhesion amount of Metal oxide is 0.6 $\mu g/cm^2$ and based on the ratio of BaO/SiO_2 of 1/2, the total adhesion amount of Mixed Oxide is 1.8 $\mu g/cm^2$ ($1.8x10^{-6}$ g/cm^2).

The thickness of the Mixed oxide layer is equal to the Adhesion amount of Mixed Oxide/Density of the Mixed Oxide and as shown for Example A is 0.0065 μm.

Correspondingly the values of Examples B through F are calculated and the results shown in the attached modified Table 2.

The calculated Mixed oxide layer thickness after baking according to the Examples of the claimed invention ranges from 0.0051 to 0.449 μm. In comparison, in Example 1 of Watanabe (U.S. 6,106,610) the Ba-containing film has a thickness of about 0.2 mm (200 μm).

Therefore, the surface modified quartz glass crucible according to the claimed invention has an extremely thin layer of concentrated crystallization promoter. This layer is very effective to crystallize the inner surface of the crucible when the crucible is used for pulling up single crystal silicon at a temperature over 1400°C even though the coated layer is very thin. Therefore, the crucible as claimed in the above-identified application has a high resistance to deformation and a significantly reduced contamination contribution to the pulled up silicon single crystal. Thus the crucible of the claimed invention is superior in performance relative to conventional crucibles.

4. The undersigned petitioner declares further that all statements made herein of his own knowledge are true and that all statements made on information and belief are believed to be true; and further that these statements were made with the knowledge that willful false statements and the like so made are punishable by fine or imprisonment, or both, under Section 1001 of Title 18 of the United States Code and that such willful false statements may jeopardize the validity of this application or any patent issuing thereon.

5. Further deponent saith not.

Yoshiyuki Tsuji
Signature

February 18, 2008
Date

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MATERIAL
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Calculation method of thickness of mixed oxide layer

Here, we use value of No.1, a kind of Silica Sol Liquid is A in Table 2 as an example.

1. Calculation of density of mixed oxide

Density of Mixed Oxide = Weight of Metal Oxide and SiO_2 / Volume of Mixed oxide

Volume of metal oxide = 1 / 5.72 = 0.175 cm^3

Density of BaO: 5.72g/cm^3 (Specific gravity of BaO)

Volume of SiO_2 = 2 / 2.2 = 0.909 cm^3

Density of SiO_2: 2.2 g/cm^3 (Specific gravity of SiO_2 glass)

Volume of Mixed Oxide = 0.175 + 0.909 =1.084 cm^3

Density of Mixed Oxide = 3 / 1.084 = 2.77 g/cm^3

2. Calculation of adhesion amount of Mixed Oxide

Adhesion amount of Mixed Oxide = Adhesion amount of Metal Oxide + Adhesion amount of SiO_2

Adhesion amount of Metal Oxide = 0.6 $\mu g/cm^2$ (Measured Value in Table2)

Adhesion amount of SiO_2 = 0.6 x 2 = 1.2 $\mu g/cm^2$

BaO : SiO_2 = 1 : 2 (Weight Ratio in Table 2)

Adhesion amount of Mixed Oxide = 0.6 + 1.2 = 1.8 $\mu g/cm^2$ = 1.8 $x10^{-6}$ g/cm^2

3. Calculation of thickness of Mixed Oxide layer

Thickness of Mixed Oxide layer = Adhesion amount of Mixed Oxide / Density of Mixed Oxide

Adhesion amount of Mixed Oxide = 1.8 $x10^{-6}$ g/cm^2

Density of Mixed Oxide = 2.768 g/cm^3

Thickness of Mixed Oxide layer = 1.8 $x10^{-6}$ g/cm^2 / 2.77g/cm^3 = 6.5 x 10^{-7} cm = 6.5 x 10^{-3} μm (0.0065 μm)

The similar calculations were carried out to other examples in Table 2 so as to obtain MODIFIED TABLE 2.

MODIFIED TABLE 2

No.	Kinds	Silica Sol Liquid: Oligomer solutions containging Metal Salt	Silica Sol Liquid: Dilution Alchole	Silica Sol Liquid: BaO Amounts (wt%)	Silica Sol Liquid: SiO_2 Amount (wt%)	Caluculated Mixed Oxide density (g/cm^3)*	Adhesion Amount of Metal Oxide after Baking ($\mu g/cm^2$)	Caluculated Adhesion Amount of Mixed Oxide after Baking ($\mu g/cm^2$)	Caluculated Mixed Oxide Layer Thickness after Baking (μm)
1	A	(Ⅰ) 20g 5wt.% Calculated as BaO 20g	Buthanol 60g	1	2	2.77	0.6	1.8	0.0065
2	B	(Ⅰ) 20g 5wt.% Calculated as BaO 40g	Buthanol 40g	2	2	3.17	0.8	1.6	0.0051
3	C	(Ⅰ) 5g 10wt.% Calculated as BaO 50g	-	5	5	3.17	1	2	0.0063
4	D	(Ⅱ) 40g 10wt.% Calculated as BaO 50g	Isoamyl 10g	5	10	2.76	5.2	15.6	0.0565
5	E	(Ⅱ) 80g 10wt.% Calculated as BaO 20g	-	2	20	2.33	9.5	104.5	0.449
6	F	(Ⅰ) 100g Carbonic Acid Ba Powder 0.5g	-	0.4	10	2.26	2.1	54.6	0.242
7	G	Non-Surface Treatment					0		
8	H	Conventional Ba carbonate Powder					1		

*: Using densities are 5.72 g/cm^3 for BaO and 2.2 g/cm^3 for SiO_2.